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Canadian Science Advisory Secretariat
Quebec Region | Science Advisory Report 2017/003

THE SAGUENAY FJORD WINTER RECREATIONAL GROUNDFISH FISHERY

Photo: J. Gauthier

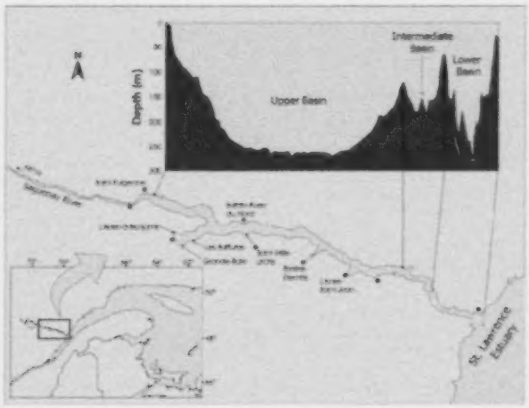

Figure 1. Main winter recreational fishing sites in the Saguenay Fjord

Context:

The winter recreational fishery in the Saguenay Fjord took off in the early 1980s. It is unique in Quebec because of its size and the variety of species caught in the area. Its socio-economic benefits help drive the area's tourism industry.

As a result of the growing interest in this recreational and tourism activity in the mid-1990s, several stakeholders are now concerned about resource conservation and sustainable development of this fishery. In this context, a monitoring program was launched in 1995 involving various parties including: Saguenay Fjord fishermen associations and committees, Promotion Saguenay, Société des établissements de plein air du Québec and the Parks Canada Agency, which co-manage the Saguenay–St. Lawrence Marine Park, as well as Fisheries and Oceans Canada (DFO).

The main groundfish species caught in this winter recreational fishery are, in order of importance, Redfish, Atlantic Cod, Greenland Cod and Greenland Halibut. Recent scientific studies have found that marine fish in the Saguenay Fjord are sink populations whose recruitment depends on the arrival of juveniles from the St. Lawrence Estuary.

A resource assessment is performed every two years, and the main indicators are based on winter recreational fishery data and abundance indices from a DFO research survey.

This assessment was prepared in response to a request by Fisheries Management regarding the status of the winter recreational groundfish fishery in the Saguenay Fjord. This fishery is currently managed by way of a fishing season and daily catch limits.

SUMMARY

- The winter recreational fishery in the Saguenay is very popular with an annual average (1998–2014) of nearly 1,500 cabins set up on the pack ice. In the 2016 season, the number of cabins is below this average due to insufficient ice cover, which has delayed and even prevented some fishing villages from being set up.

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- The success of fishing is low, and more than 90% of the time, fishermen do not catch their daily limit of five groundfish.
- During the winter recreational fishery in 2015 and 2016, Redfish, Atlantic Cod, Greenland Cod and Greenland Halibut (turbot) accounted for 85%, 8%, 3% and 4% of groundfish catches, respectively.
- The number of Redfish catches per unit effort (NUE) from the fishery and the research survey dropped significant before 2005 and has stabilized at a low level, below the respective series average since then.
- Fishery and survey NUE for Atlantic Cod, Greenland Cod and Greenland Halibut are low. However, since 2013 there has been an increase in NUE in the Atlantic Cod and Greenland Halibut fisheries with values above their series average.
- Groundfish recruitment in the Saguenay relies on the arrival of juveniles from the Estuary. Strong Deepwater Redfish (*Sebastes mentella*) year-classes (2011, 2012 and 2013) were noted in the Estuary, and they were more abundant than in the last 30 years.
- These new Redfish cohorts have been observed in the Saguenay Fjord since 2013 by recreational anglers and since 2014 in the DFO scientific survey.
- Redfish are slow growing and long-lived. According to estimates of Redfish growth in the Gulf, nearly 50% of the fish in the 2011 cohort will exceed 22 cm in the summer of 2018.
- The medium-term outlook is encouraging for the winter recreational Redfish fishery in the Saguenay Fjord. Until then, juvenile catches will have to be kept to a minimum in order to help rebuild the biomass.
- Since groundfish in the Saguenay are part of a unique ecosystem, their populations must be protected in accordance with the Precautionary Principle. It would be appropriate to keep effort and catch levels about where they have been in recent years.

BACKGROUND

Circulation and renewal of Saguenay Fjord waters

Two recent studies have refined knowledge concerning the Saguenay Fjord water renewals as well as the speed of the process (Bourgault et al. 2012; Belzile et al. 2016). These studies showed the existence of three regimes of water renewal which depend on the salinity (and thus the density) of the Estuary waters that are present at the first sill of the Fjord. This density varies seasonally and determines the intrusion depth of waters into the Fjord (Figure 2). The renewal time of the Saguenay Fjord upper basin waters is estimated to vary from 1 to 6 months. Two recent 2016 samplings made less than two months apart, in June and August, indicated an almost complete renewal of waters of the Fjord during this period.

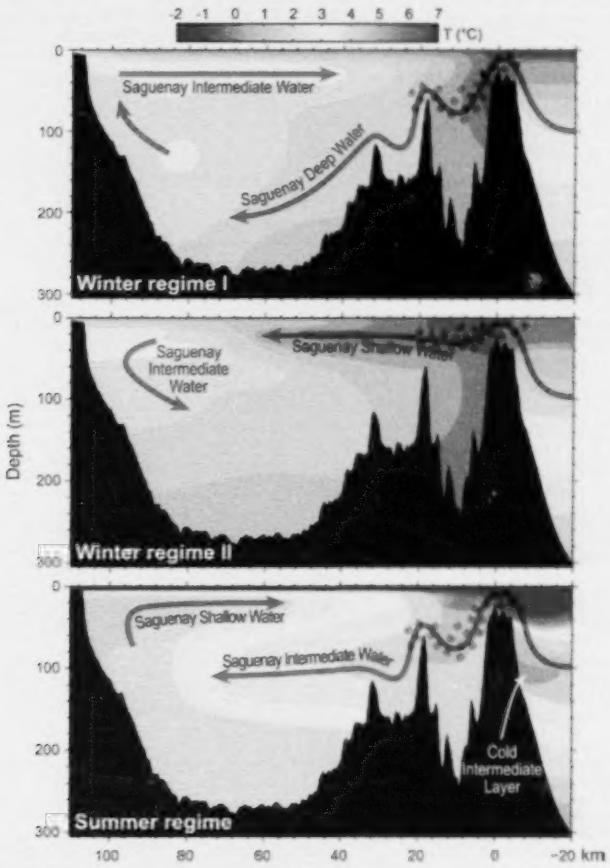


Figure 2. Illustration of the three types of renewal regimes in the Saguenay Fjord. Top panel; winter regime I, deep renewals during fall and early winter, when the density of the waters in the Estuary is high. Middle panel; winter regime II, subsurface renewals occurring mid or late winter. Bottom panel; summer regime with intermediate water renewals during summer. From Belzile et al. 2016.

Saguenay Fjord groundfish

The main groundfish species caught in the Saguenay Fjord winter recreational fishery are, in order of importance, Redfish *(Sebastes* spp.), Atlantic Cod (*Gadus morhua*), Greenland Cod (*Gadus ogac*) and Greenland Halibut (*Reinhardtius hippoglossoides*), also called Turbot. Rainbow Smelt (*Osmerus mordax*), a pelagic species, is also of considerable interest to fishermen. Those interested in obtaining information on Rainbow Smelt in the Saguenay Fjord may contact the Direction de la gestion de la faune du Saguenay-Lac-Saint-Jean [Saguenay-Lac-Saint-Jean Wildlife Management Branch] of Quebec's Ministry of Forests, Wildlife and Parks.

Studies published in the late 2000s suggested that marine fish populations in the Saguenay Fjord are "sink" populations whose recruitment depends on the arrival of juveniles from the St. Lawrence Estuary. Once these fish settle in the Saguenay, they spend most of their life there. The status of Saguenay marine fish populations would therefore be closely tied to the status of populations in the Estuary and Gulf of St. Lawrence.

Some St. Lawrence fish stocks are in a precarious situation and have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). As a result, southern Gulf cod, Deepwater Redfish and White Hake have all been designated as endangered species by COSEWIC. In addition, the commercial cod fishery in the southern Gulf of St. Lawrence has been under a moratorium since 2009, and the findings of the latest Science Advisory Report are not optimistic. They indicate it is highly unlikely that this stock will recover, even in the absence of fishing (DFO 2016a).

The latest Redfish data are more encouraging (DFO 2016b). High abundances of juvenile Redfish have been identified in the Estuary from 2013 to 2016. Genetic analyses have confirmed that these new cohorts are composed nearly entirely of Deepwater Redfish (*S. mentella*) from the northern Gulf population, a species found in the Saguenay. These new Redfish cohorts have been observed in the Saguenay Fjord since 2013 by recreational anglers and since 2014 by the DFO scientific survey. Since 2014, it has also been noted that small Redfish have been caught at shallow depths in the Smelt fishery, and these catches have likely increased significantly in 2016.

Description of the fishery and conservation measures

The winter recreational groundfish fishery in the Saguenay Fjord took off in the early 1980s. It does not require a licence and has been monitored by DFO since 1995. Existing conservation measures focus mainly on two aspects: 1) the length of the fishing season and 2) the groundfish daily catch limit. The fishing season was shortened in 2005 and 2011 from an average of 59 days between 2005 and 2009 to 43–45 days since 2011. The daily limit was decreased from 25 to 15 groundfish in 2003, and then to five in 2004. The regulations also contain a mandatory release clause for certain species, set a maximum soak time and prohibit the sale, barter and waste of fish.

The fishery extends throughout the entire upper basin of the Saguenay Fjord, between Saint-Fulgence and Petit-Saguenay (Figure 1). Activities are mainly concentrated in eight fishing villages (Figure 1): L'Anse-Saint-Jean, Rivière-Éternité, Saint-Félix-d'Otis, Sainte-Rose-du-Nord, Saint-Fulgence, l'Anse-à-Benjamin, Grande-Baie and Les Battures. The Les Battures site has been closed since 2013, and in 2016 weather conditions prevented the Sainte-Rose-du-Nord village from being set up. On average, 1,500 cabins are set up in these villages every year. In 2015 and 2016, 1,427 and 1,212 fishing cabins were set up in the area (Guy Girard, Promotion Saguenay, personal communication). Over 80% of the cabins were in the three fishing villages in La Baie: Anse-à-Benjamin, Grande-Baie and Les Battures.

Fishing sites generally include two areas: a pelagic fish area near shore where smelt is the main catch, and a groundfish area further out on the ice where the species discussed in this report are caught. The second area is located in deeper waters where 60% of all cabins are set up, all sites included.

Fishermen use two main types of gear: a conventional or short fishing rod and a roller. The roller consists of a line mounted on a pulley and has largely replaced tip-ups. Rollers and tip-ups are generally set up on the pack ice outside the cabins, while hand lines are primarily used inside the cabins. Ice fishing is characterized by three main types of behaviour. The first is characteristic of fishermen paying close attention to the gear. When the fish takes the hook, the fisherman removes the line, unhooks the fish, and baits and sets the line again. The second behaviour involves social activities. The gear is baited and lowered into the water, but the fishermen do not watch the gear as attentively. As a result, a fish that takes the bait can be hooked to the line for a number of hours before being pulled out. This means there is virtually no

chance that another fish will be caught with the gear during this time. The third approach involves baiting and lowering the gear in the evening, for example, and checking the lines at the beginning or end of the next day. Rollers and tip-ups are used more often with this approach. The prevalence of these three behaviours varies between sites.

The average for 1996–2014 (Figure 3) was approximately 39,000 fishermen-days. In 2008 and 2009, favourable ice conditions resulted in above average numbers. However, in 2010, sites were set up one to two weeks after the season opened, and fishing ended three to four weeks earlier than scheduled due to thinning ice cover, reducing the number to roughly 22,000 fishermen-days. Since 2011, a new management measure shortened the fishing season to 43–45 days, which resulted in a decrease in fishermen-days. In 2012, 2014 and 2016, fewer fishermen-days were also linked to poor ice conditions, which delayed and even prevented fishing villages from being set up. According to some local stakeholders, the new regulations for setting up cabins on the pack ice may have also reduced participation in this activity.

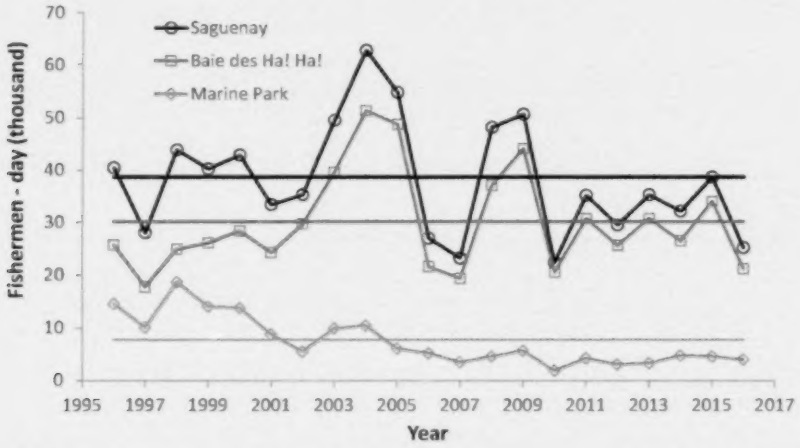


Figure 3. Annual fishermen-day index. The horizontal lines represent the three series averages for the period 1996–2014. The Saguenay combines data from all sampled sites. La baie des Ha! Ha! includes data from L'Anse-à-Benjamin, Les Battures and Grande-Baie. The marine park includes the Sainte-Rose-du-Nord, L'Anse-St-Jean, Rivière-Éternité and Saint-Félix-d'Otis sites.

ASSESSMENT

Data source

The main indicators for this assessment are from recreational fishery monitoring and abundance indices from a DFO research survey.

DFO has been monitoring the recreational fishery and marine fish populations in the Saguenay Fjord since 1995, focusing on the main species harvested, namely Redfish, Atlantic and Greenland Cod, and Greenland Halibut. This program has two components and involves the participation of fishermen recruited from the main fishing villages and several stakeholders who collaborate closely: Parks Canada, SEPAQ and Promotion Saguenay. They all contribute significantly to monitoring marine fish populations harvested in the Saguenay Fjord.

The first component of the monitoring program involves interviewing recreational fishermen. The aim for each fishing season is to visit each site 20 times and interview 15 fishermen each time. The visits are conducted on weekdays and weekends throughout the fishing season. Data are

gathered on catches (species, number), fishing effort (number of line, hooks and hours fished) and number of active fishermen at the time of the visit. The main purpose is to identify trends in catches per unit effort (NUE). Depth sounder use has also been tracked since 2010. The second component of recreational fisheries monitoring involves collecting biological data on the main species caught (fishing site, date, species, size and weight of fish caught).

Since 2000, DFO's Regional Science Branch has been using a Coast Guard research vessel to conduct a research survey in the Saguenay Fjord. This gillnet survey, conducted annually from 2000 to 2010 and now every two years, takes place in early spring. Sampling stations are grouped together at eight sites in the La Baie des Ha! Ha! and Bras du Nord areas, upstream from the Saguenay-St. Lawrence Marine Park boundary. Annual fishing effort has increased from about 30 sets during the first few years of the survey to an average of 74 between 2006 and 2016.

Several factors account for the sometimes divergent trends in the winter recreational fishery and research survey indices:

1) The activities do not take place at the same time of year. The fishery takes place in the winter from January to early March, while the survey is conducted in April–May. The fish may move for feeding or breeding purposes.
2) The activities do not occur in the same geographical area. The survey focuses on eight sites located in Baie des Ha! Ha! and Bras du nord. It does not cover fishing village sites in the marine park (Sainte-Rose-du-Nord, Anse-St-Jean, Rivière Éternité and St-Félix-d'Otis).
3) The gear is selective. Recreational fishing hooks and the 5.5-inch gillnets used in the DFO survey do not necessarily target the same cohorts.

Resource status

Redfish

Redfish is the most widely harvested species during the winter recreational groundfish fishery in the Saguenay Fjord, accounting for 85% of catches in 2015 and 2016.

For the Saguenay as a whole, the recreational fishery catch rate index showed a continuous downward trend from 1996 to 2006, followed by stabilization at low values (Figure 4A). The 2015 and 2016 values were low and below the series average.

This general downward trend is also evident in the research survey abundance index, which decreased significantly between 2000 and 2008, and then stabilized at low values since 2005 (Figure 4B).

Fishing gear, hook and lines in the recreational fishery and gillnets in the DFO research survey, have different selectivity. Hook and lines are less selective and catch a wider range of fish sizes than gillnets (Figures 5A and B). Redfish less than 20 cm are occasionally caught in the recreational fishery, indicating the sporadic presence of young individuals. However, the gradual increase in median size from 28 cm to 32 cm between 1996 and 2015 suggests that the recreational fishery has not experienced a major inflow of recruits and that the fishery focuses on a small number of cohorts. In 2016, the average size decreased because more small Redfish were caught, whose contribution to the fishery is still low. The DFO survey cannot assess recruitment due to the restricted selectivity of 5.5-inch mesh gillnets, and the size range of Redfish remains fairly similar year after year. In 2016, the 1.5- and 2.63-inch gillnets used in the DFO survey caught juvenile Redfish ranging from 8 cm to 18 cm in size, possibly the 2011 to 2014 cohorts.

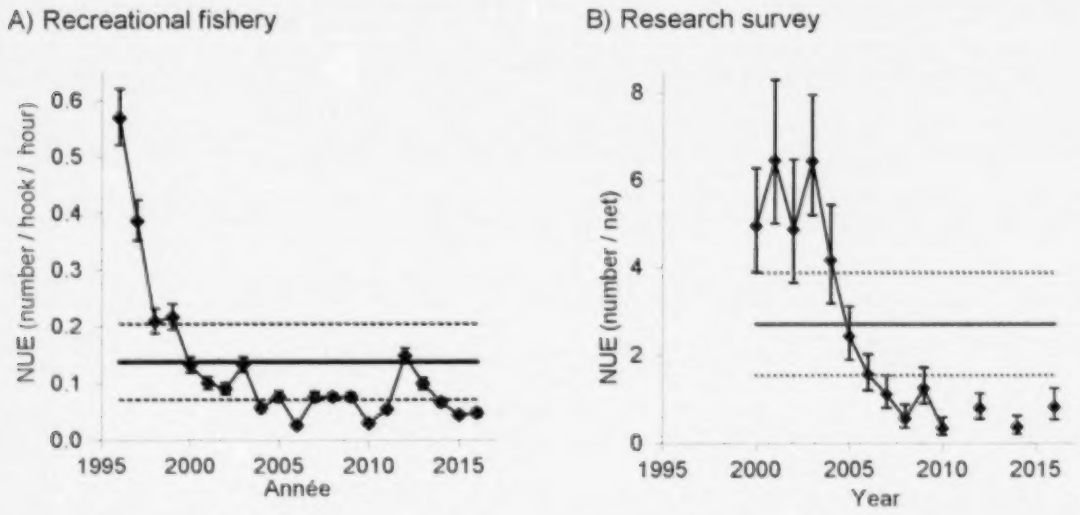


Figure 4. Annual Redfish catch rate in numbers per unit effort (NUE) in the recreational fishery (A) and the research survey (B). The vertical lines represent a 95% confidence interval. The solid horizontal lines indicate the series average and the dotted upper and the lower horizontal lines indicate reference limits.

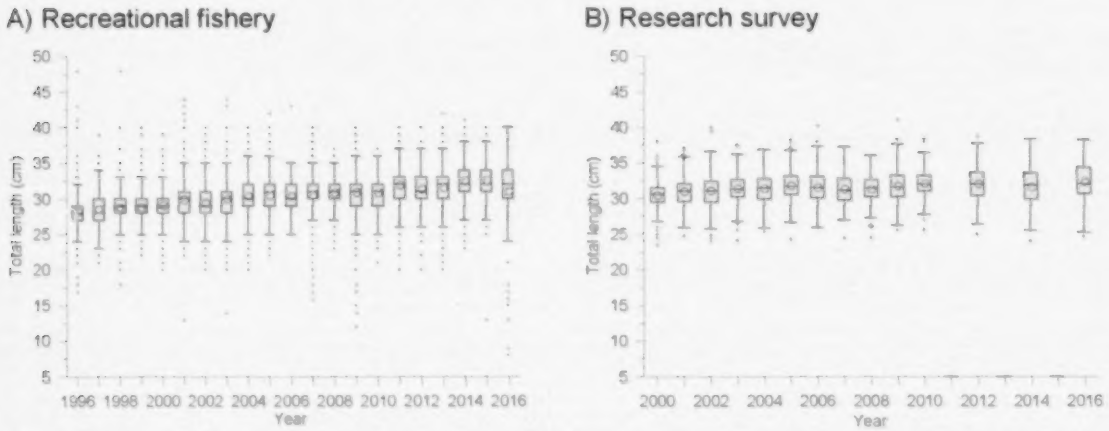


Figure 5. Annual distribution of Redfish size frequencies in the recreational fishery (A) and the 5.5-inch gillnet survey (B). Box-and-whisker plot: the median is shown by the line in the middle of the box. The box ranges from the 25th to the 75th percentile. The whiskers (vertical lines on each side of the box) represent 1.5 times the interquartile range (distance between Q1 and Q3). The circle represents the average, and the crosses represent outliers.

The estimated total Redfish catch (Figure 6) in the winter recreational fishery has been on a general downward trend between 1998 and 2016, with significant annual variations. These estimates are largely influenced by the annual sampling of fishing activities. In 2006, the significant decline in the estimated catch was largely due to the lack of sampling at the Anse-à-Benjamin site, which on average accounts for 20% of the total annual fishing effort.

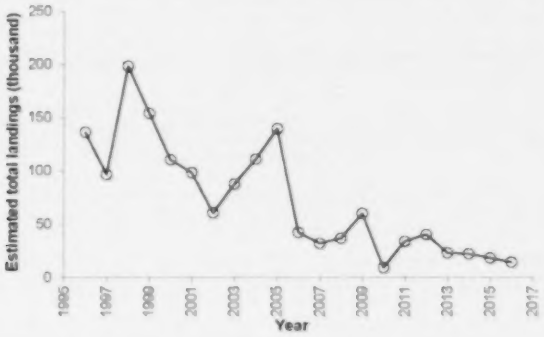


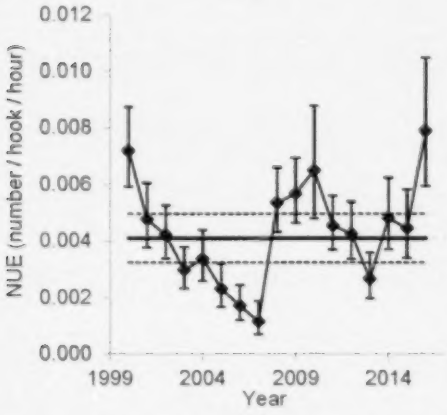
Figure 6. Estimated total landings of Redfish in the recreational fishery.

Atlantic Cod

Recreational fishery abundance indices began in 2000, when cod species started to be distinguished. Generally, Atlantic Cod catch rates are low. The recreational fishery abundance index (Figure 7A) decreased between 2000 and 2007 for the Saguenay as a whole. The index surged in 2008 and continued to increase until 2010 when the value was close to initial values in the series. It then declined until 2013 and has been rising since then. The 2016 index was the highest in the series.

Atlantic Cod catches were also low in the DFO research survey (Figure 7B). Between 2 and 66 cod have been caught per survey since the beginning of the series, and 10 Atlantic Cod were caught in the 2016 survey. The catch rate index fluctuated without any clear trend between 2000 and 2005. The index then increased until 2010 with a value above the series average. The index has been decreasing since then and was below the series average in 2014 and 2016.

A) Recreational fishery



B) Research survey

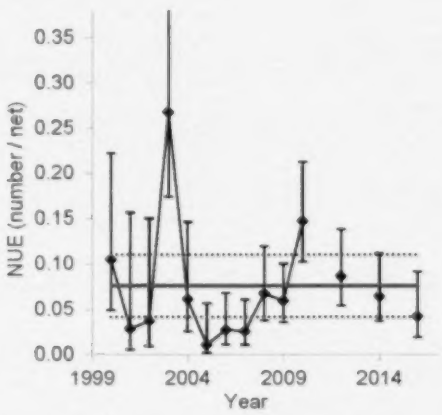


Figure 7. Annual Atlantic Cod catch rate in numbers per unit effort (NPUE) in the recreational fishery (A) and the research survey (B). The vertical lines represent a 95% confidence interval. The solid horizontal lines indicate the series average and the dotted upper and the lower horizontal lines indicate baseline levels.

The small number of Atlantic Cod measured both in the recreational fishery and the research survey prevents separate tracking of cohorts. The wide range of sizes in cod catches (20 cm–

100 cm) and the presence of fish less than 30 cm every year in the recreational fishery (Figures 8A and B) indicate a regular inflow of new individuals into the Saguenay population.

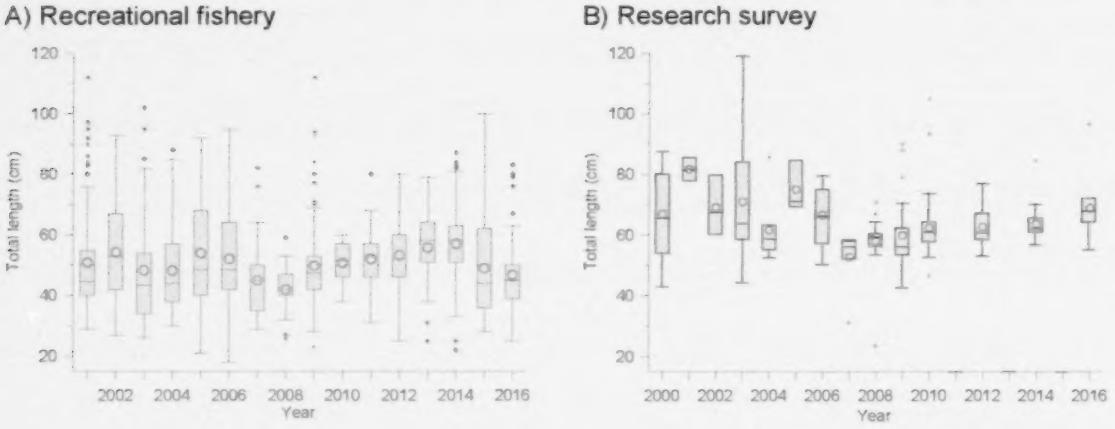


Figure 8. Annual Atlantic Cod size frequency distribution from the recreational fishery (A) and the research survey (B) Box-and-whisker plot: the median is shown by the line in the middle of the box. The box ranges from the 25th to the 75th percentile. The whiskers (vertical lines on each side of the box) represent 1.5 times the interquartile range (distance between Q1 and Q3). The circle represents the average, and the crosses represent outliers.

The estimated total Atlantic Cod landings (Figure 9) in the recreational fishery fluctuate significantly, peaking in 2004 and hitting bottom in 2007. Since 2012, the estimated annual value has stabilized at an average of roughly 1,330 cod.

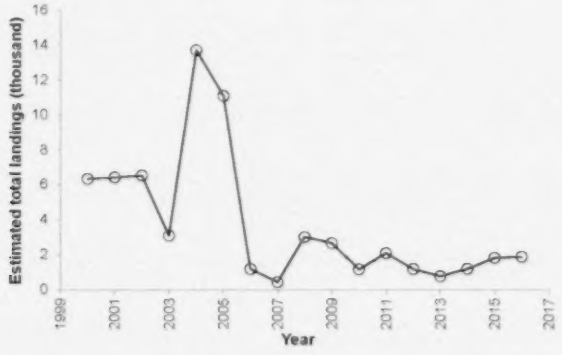


Figure 9. Estimated total landings of Atlantic Cod in the recreational fishery.

Greenland Cod

Greenland Cod catch rates are low. Throughout the Saguenay, the abundance index of Greenland Cod in the recreational fishery decreased (Figure 10A) between 2000 and 2007, and with the exception of 2014, values have been below the series average since 2005.

Greenland Cod is also an occasional catch in the research survey, making data interpretation somewhat uncertain. Greenland Cod catches have ranged from 1 to 23 fish per survey.

Nevertheless, this abundance index seems to have decrease between 2000 and 2008, and then stabilized at a low level below the series average since 2006 (Figure 10B).

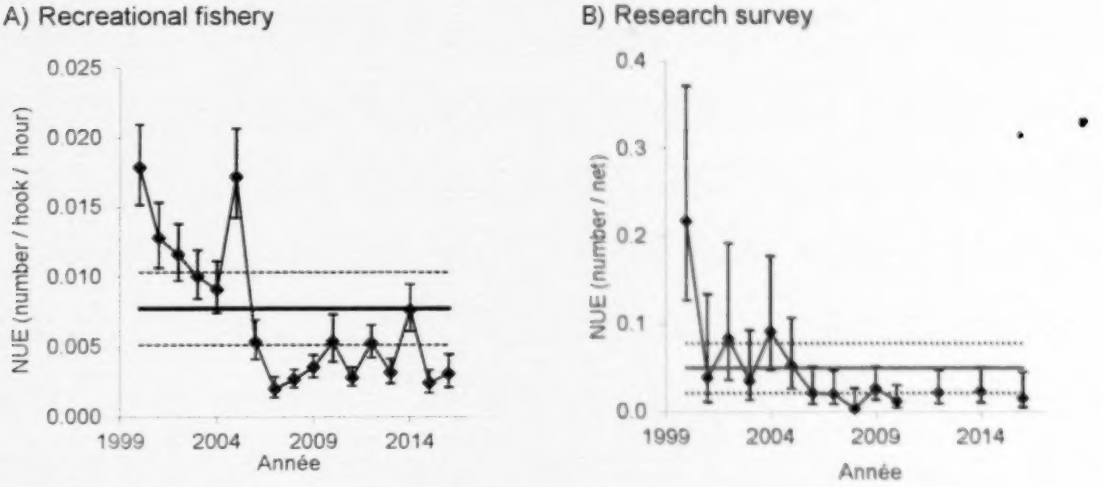


Figure 10. Annual Greenland Cod catch rate in numbers per unit effort (NUE) in the recreational fishery (A) and the research survey (B). The vertical lines represent a 95% confidence interval. The solid horizontal lines indicate the series average and the dotted upper and lower horizontal lines indicate baseline levels.

Cohorts cannot be monitored due to the small number of Greenland Cod caught in the recreational fishery and the DFO research survey (Figure 11). However, a regular presence of individuals less than 35 cm has been noted in the recreational fishery, suggesting a constant inflow of young fish.

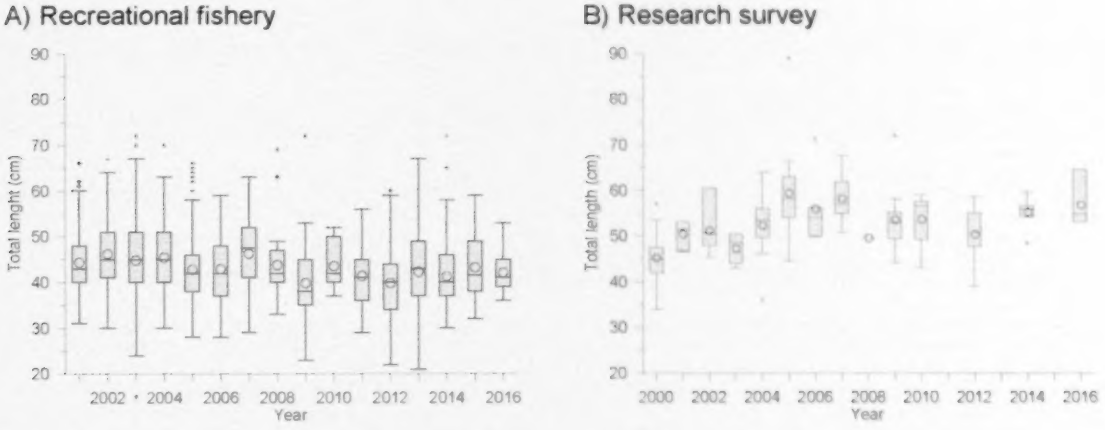


Figure 11. Greenland Cod size frequency distribution from the recreational fishery (A) and the research survey (B). Box-and-whisker plot: the median is shown by the line in the middle of the box. The box ranges from the 25th to the 75th percentile. The whiskers (vertical lines on each side of the box) represent 1.5 times the interquartile range (distance between Q1 and Q3). The circle represents the average, and the crosses represent outliers.

The estimated total landings of Greenland Cod (Figure 12) in the recreational fishery decreased significantly between 2000 and 2007 from 27,101 to 563 fish, and then stabilized at an average annual value close to 1,190 individuals.

Figure 12. Estimated total landings of Greenland Cod in the recreational fishery.

Greenland Halibut

Greenland Halibut are seldom caught in the Saguenay recreational fishery, which makes interpreting catch rates as an abundance index very speculative (Figure 13A). Nevertheless, an increase was noted between 2013 and 2016. However, research survey catches were high and this abundance indicator suggests higher catch rates between 2005 and 2012 than in the period 2000–2004 (Figure 13B). In 2014, the index decreased sharply, below the series average at a level similar to 2000–2004 values.

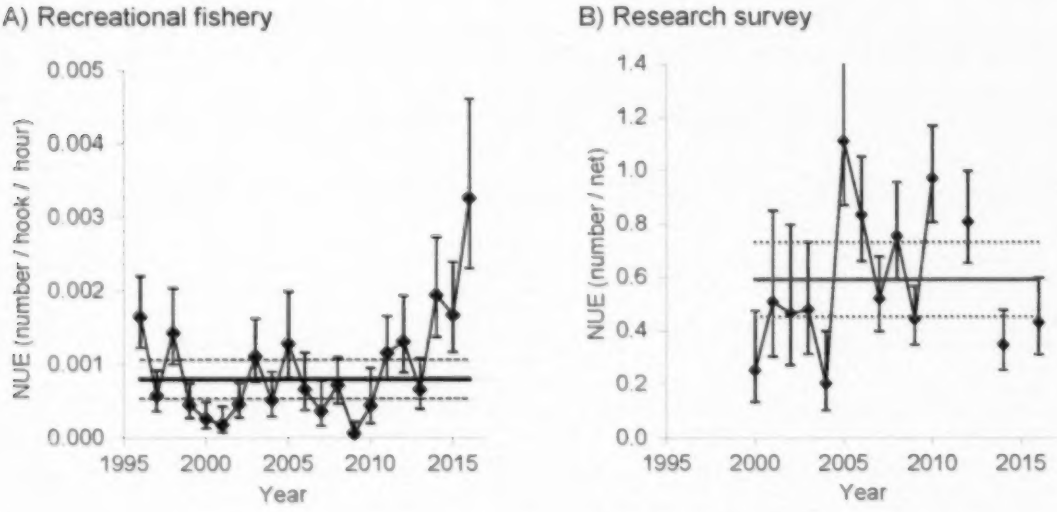


Figure 13. Annual Greenland Halibut catch rate in numbers per unit effort (NUE) in the recreational fishery (A) and the research survey (B). The vertical lines represent a 95% confidence interval. The solid horizontal lines indicate the series average and the dotted upper and lower horizontal lines indicate baseline levels.

Greenland Halibut size structures in the recreational fishery and the research survey indicate the presence of several cohorts in the Saguenay (Figure 14).

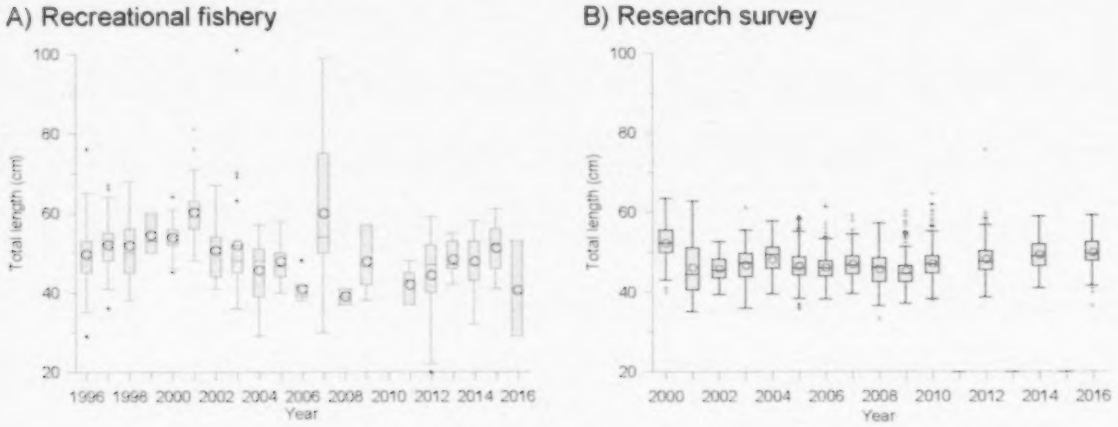


Figure 14. Greenland Halibut size frequency distribution from the recreational fishery (A) and the research survey (B). Box-and-whisker plot: the median is shown by the line in the middle of the box. The box ranges from the 25th to the 75th percentile. The whiskers (vertical lines on each side of the box) represent 1.5 times the interquartile range (distance between Q1 and Q3). The circle represents the average, and the crosses represent outliers.

Estimated total catches in the recreational fishery are generally low and strongly influenced by sampling (Figure 15). Since catches at a site are multiplied by the effort at that site, a few extra fish at a very busy site will produce a large variation. The estimated average annual catch over the last 10 years is 416 individuals.

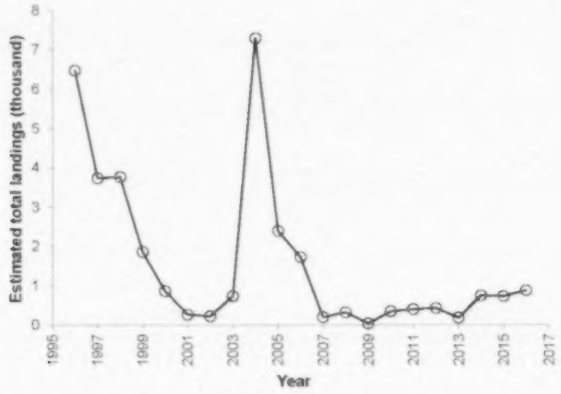


Figure 15. Estimated total landings of Greenland Halibut in the recreational fishery

Sources of uncertainty

Annual effort (Figure 3) and, consequently, total catch (Figures 6, 9, 12 and 15) calculations are based on the length of the fishing season, average number of active fishermen per day and, for the total catch, the average daily effort. The approximation methods used to determine these

three variables contain many biases, and the available information is insufficient to quantify their uncertainty.

Theoretically, the best abundance indices completely cover a stock in terms of its geographic range and the extent of its year-classes (area sampled and gear selectivity). It is also preferable that sampling be conducted when the fish are dispersed and catchable. For the Saguenay Fjord, we only have partial abundance indices. The recreational fishery takes place in winter in very localized areas in bays of medium depth. Spatial coverage is therefore limited compared to the expected distribution of the target species. The gear used, hook and line, is selective enough to catch a fairly wide range of fish sizes, but is not equally effective for all sizes. The DFO survey is not optimal either. Spatial and temporal coverage is limited and the gear used, gillnets, has a fairly narrow selectivity that targets certain ranges of adult fish sizes. The survey does not indicate that fish populations are being recruited in the Saguenay. Smaller mesh nets were used in the 2014 and 2016 DFO surveys to develop recruitment indices for Saguenay groundfish populations. Juvenile Redfish ranging from 8 cm to 18 cm were caught.

CONCLUSIONS AND ADVICE

The Saguenay winter recreational fishery is very popular with an annual average of nearly 1,500 cabins set up on the pack ice. The five groundfish daily catch limit is not restrictive since the limit is not caught in more than 90% of fishing activities.

Abundance indices based on the recreational fishery and the gillnet survey show a significant decline in Redfish, by far the main species caught in this fishery. However, the medium-term outlook is encouraging because high abundances of juvenile Redfish were identified in the Estuary and Gulf of St. Lawrence between 2013 and 2016. These high abundances were also observed in the Saguenay. However, in the short term, harvesting should contribute to a lower abundance of adult Redfish.

Redfish are slow growing and long-lived. According to estimates of Redfish growth in the Gulf, nearly 50% of the fish of the 2011 cohort will exceed 22 cm in the summer of 2018. However, our knowledge of Redfish growth in the Saguenay is limited, and a recent study suggested that Redfish growth in the Saguenay is slower than for the same cohort in the Gulf of St. Lawrence.

Catch rates for the winter recreational Atlantic Cod, Greenland Cod and Greenland Halibut fisheries are low. However, since 2013 there has been an increase in the Atlantic Cod and Greenland Halibut fishery indices with values above their respective series averages.

Since groundfish in the Saguenay are part of a unique ecosystem, their populations must be protected in accordance with the Precautionary Principle. It would be appropriate to keep effort and catch levels about where they have been in recent years.

OTHER CONSIDERATIONS

Local participants in the peer review presented a new initiative to reduce juvenile Redfish catches in the smelt fishery. The initiative involves relocating some smelt fishing villages to ensure that the fishery is conducted at depths of less than 30 feet.

Monitoring process for interim years

Saguenay Fjord marine fish populations targeted by the winter recreational fishery are assessed every two years. It was agreed at the November 10, 2016 assessment that sampling and data

collection would continue throughout the interim year, but that indicators would not be monitored.

SOURCES OF INFORMATION

This Science Advisory Report stems from the November 10, 2016 meeting on the Saguenay Fjord winter recreational groundfish fishery. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

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